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THE CULTIVATION OF FOOD-STUFFS.

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Cereal Crops.

A MEMORANDUM on cereals, pulses and root crops was circulated to estate managers by the Department of Agriculture a few months ago. In that paper it was pointed out that the cultivation of these crops was but little known in the Malay Peninsula. It was announced in the memorandum that seeds of most of the crops dealt with could be had upon application to the Agriculturist, Federated Malay States. A ready response followed and it will be interesting to give here a summary of the material distributed to applicants throughout the Peninsula for the first six months of the year.

Food-stuff Planting Material supplied by the Department of Agriculture, F.M.S.

January 1st to March 31st, 1918.

Crop.	No. of Estates.	Total quantity.
Cereals—		
Italian millet	41	180 lbs.
Sorghum	39	187 „
Ragi	39	371 „
Maize	16	46 „
Bulrush millet	5	11 „
Pulses—		
Phaseolus mungo	44	276 „
Mucuna utilis	2	7 „
Root crops—		
Jerusalem artichokes	8	20 „
Sweet potato cuttings	5	5 bundles
Tropical vegetables—		
Brinjal, white	38	38 pckts
„ purple	42	42 „
Ceylon spinach	33	34 „
Capsicum	28	28 „
Egyptian kidney bean	31	31 „
Ladies' fingers	46	47 „
Pumpkin, white	32	32 „
„ yellow	33	33 „

April 1st to June 30th, 1918.

Crop.	No. of Estates.	Total quantity.
Cereals—		
Italian millet	27	483 lbs.
Sorghum	27	259 „
Ragi	60	2,157 „
Maize	11	123 „
Padi	3	1,335 „
Kambu	3	62 „
Pulses—		
Phaseolus mungo	9	82 „
Mucuna utilis	5	27 „
Pigeon-pea	4	8 „
Root crops—		
Artichokes	11	41 „
Sweet potato cuttings	11	13 bundles
Yams	85	24,499 lbs.
Tropical vegetable seeds—		
Brinjal, white	69	69 pckts.
„ purple	61	61 „
Capsicum	34	34 „
Kidney bean	75	76 „
Ladies' fingers	59	59 „
Pumpkin, white	70	70 „
„ yellow	65	65 „
Goa beans	44	45 „
European vegetable seeds—		
Mustard	5	5 „
Lima bean	5	5 „
Lettuce	18	18 „
Turnip	6	8 „
Radish	11	13 „
Kohl-rabi	6	6 „

It has been intimated elsewhere that a comprehensive series of experiments on imported food-stuffs is in progress by the Department of Agriculture. A piece of land, 46 acres in extent, situated on Petaling Hill, Kuala Lumpur, where it is proposed to hold a demonstration at a later date, is being utilised for this purpose. A variety of cereal, pulse, and root crops are under trial at that place and it is intended to publish, at an early date, the results obtained, in the form of a special bulletin. It is felt, however, that all available information regarding these crops should be placed at the disposal of planters in this country at the present time.

Preliminary trials have been made with several of the cereals on small experimental plots at the Kuala Lumpur Government Plantation. Fairly large areas of ragi, sorghum, Italian millet and, to a lesser extent, bulrush millet have been grown at Castleton Estate, Telok Anson, and at the Government Plantation, Kuala Tembeling, Pahang. Considerable success was obtained at the latter place during 1917 but the soil there is particularly suited for the cultivation of such crops and superior to the majority of soils in

many parts of the Peninsula. The land on Petaling Hill was selected as being typical of soils met with in Selangor, though the low coastal lands would probably be eminently suitable.

Several estates in Selangor, which have taken up the cultivation of cereals for the purpose of feeding their Tamil labour force, have been visited by the writers. Good progress has been observed and, judging from reports received from various parts of the country, it appears evident that the cultivation of cereals is meeting with a considerable amount of success. It seems probable that soon the majority of estates, having suitable land, will seriously consider the production of cereal crops.

LAND.

The following Notification No. 2823 appeared in the *Government Gazette* of the 14th September, 1917. With a view to encouraging the planting of food-stuffs and increasing the local production of food, the following measures have been adopted by the Government:

1. All restrictions at present in force with regard to the planting of tapioca and for any other food-stuff on alienated land are suspended.
2. All land, whether held on annual licence or permanent title, used exclusively for the growing of vegetables, bananas and pineapples will be given rent free for the next five years, no other cultivation being allowed. This applies also to any estate which devotes a part of its land exclusively to food cultivation.
3. Any restrictions which at present exist with regard to the growing of food-stuffs on mining land will be suspended for five years.
4. All restrictions on the planting of hill padi on alienated lands (except land alienated for wet padi) are suspended.
5. Portions of reserves along the Federated Malay States Railway lines will be let to approved applicants for planting vegetables and other food-stuffs. The conditions may be ascertained on application to the General Manager, Federated Malay States Railways.

With reference to paragraph 2 it is notified (No. 1548, *Government Gazette*, 24th May, 1918,) that for the next five years no rent will be charged on land used exclusively for the growing of cereals other than padi.

In many instances, rubber and coconut clearings, up to $2\frac{1}{2}$ years old, are suitable for the cultivation of cereals and the utilisation of even a small proportion of this land, in this connection, would materially affect the food question, here, in a beneficial way. We are confident that a new clearing can support one or perhaps more annual crops, which take a matter of a few months to mature, without, to any appreciable extent, injurious results to the permanent crop. It is quite possible that the culture and tilth required for the reception of a temporary crop will more than compensate for any materials removed from the land. The resultant stubble when changkolled into the ground considerably assists in improving the mechanical condition of the soil and in this way benefits the permanent crop. On old estates small plots can generally be found around buildings, in unplanted spaces and ravines. The latter

when properly cleared and cultivated often afford fertile land, particularly where the situation faces the east. A system of contour terraces is generally required to render ravine slopes suitable for agricultural purposes. In many cases the ravines are not planted with a permanent, or any revenue-producing, crop and consequently are available for the growing of food-stuffs whereby they would serve a useful purpose. Lalang land thoroughly freed from weeds and blukar areas can generally be made suitable, and has the advantage of little or no timber on the land. Semi-swamps, when well-drained will yield comparatively good ragi crops and there is quite an abundance of land which might be turned to good account in this way. Jungle, as a rule, is first class land for growing cereal crops and is to be recommended provided the land is not too steep.

LABOUR.

The labour question is perhaps the most serious difficulty involved in the growing of these crops. Some estate managers advocate the giving up of a piece of land to the labour force for their sole use in growing food-stuffs and providing them with the initial planting material. Can it reasonably be expected that as good results will be obtained when coolies are left to their own initiative as regards preparation of the land and general control? Better returns will be obtained where the crops and produce, are under estate managers' supervision, no individual cooly can then work the land as he thinks best or grow whatever crop he pleases. Whether the work should be done during estate working hours or overtime is a question which must be considered by each individual manager. It must be remembered that annual crops of this nature require constant labour and attention and it is a mistake to plant up larger areas than can be properly supervised.

ROTATION OF CROPS.

If land is to be used for the growing of food-stuffs for any extended period, then a rotation of crops should be adhered to. Two or three ragi or other cereal crops may be grown on recently opened up land but it would be extremely short-sighted to continue this policy for any length of time. It is obvious why a change is to be recommended. In the first place the food requirements of different families of plants are varied and the continual extraction of one or more ingredients from the soil, results in its becoming unbalanced but what is perhaps equally important is a rotation of deep and shallow rooted crops thereby drawing food material from different layers of the soil. A leguminous crop should take its place in any rotation as the nitrogenous matter when dug into the soil, is a valuable fertiliser. Certain crops are more susceptible to particular diseases and the eradication of such diseases is often permanently effected by the introduction of an unsuitable host.

In making the selection of a rotation of food crops one is to a certain extent limited in numbers in this country but a general rule is that plants of the same natural order should not follow one another. Root crops, cereals and leguminous plants may be grown in rotation. In young rubber or coconut clearings, where catch-crops can only be grown for a time this is not so necessary but with land devoted solely to the permanent cultivation of food-stuffs then a rotation is of paramount importance.

CULTIVATION.

This is of vital importance in the growing of cereal crops. A good harvest cannot be expected without thorough treatment of the soil but there is considerable variation in degree of tillage according to the nature of the land. Soils which are friable require the minimum amount of work and the preparation of the ground to a depth of a few inches, thereby providing a good surface tilth, is generally all that is required. It should not be assumed from this that light soils will necessarily give the best yields but merely require the minimum amount of cultivation. For instance, very light soils do not retain sufficient moisture for the requirements of the majority of cereals but a few are particularly adapted to such conditions and give their returns on these areas. Land which has been under lalang or other grasses for any length of time requires preliminary deep cultivation, eradication of all weeds, temporary exposure to atmospheric conditions and subsequent tillage conducted at short intervals to be followed by surface tillage to ensure a proper tilth. Plough cultivators and harrows should be used when conditions permit from the point of view of economy and efficiency. It is not proposed here, to go in to the question of costs, this will be dealt with at a later date, in a special bulletin on food-stuffs. Heavy soils, such as clays, should have deep cultivation in order to improve their mechanical condition generally. Estate land which has undergone the normal weeding operations requires tillage to a depth of about eight inches and subsequent light cultivation. Land which rapidly consolidates after tillage should have further working.

Seed, when broadcast, must always be sown on a well-prepared surface and afterwards covered, this is effectively done by harrows but as agricultural implements are seldom used in Malaya, a primitive method can be recommended—namely, the trailing of branches with abundance of foliage over the ground.

When a crop has been harvested the stubble may be turned under and the land left fallow for a month or two prior to the preparation of the ground for a second crop.

RAGI.

Eleusine coracana.—*Kelvaragu, keppai* (Tamil), *ragi* (Hindustani and Canarese), *kurakkan* (Singhalese).

Description.—A stout tufted grass, with erect somewhat compressed culms, two feet high. Leaves arranged in two rows, large and smooth. Panicles varying from one to sixteen, each composed of from six to twelve spikes. Each spike from two to three inches long, usually incurved, composed of two rows of sessile, three to four flowered spikelets. Seeds globular, brown, somewhat wrinkled, covered with a thin aril.

Varieties.—In India a number of minor varieties are recognized; in fact each district appears to have varieties of its own. They may all, however, be divided into two main classes—

(1) Closed headed varieties called in Tamil *karunguruthai*,

(2) Open headed varieties, known as *talaivirichan*.

Distinct varieties are also in use for dry and wet lands and for early and late seasons; the only visible difference being in the nature of the panicles. Mr. A. C. Jameson in his paper[1] delivered at the Taiping Planters' Association's meeting at the Perak Club on April 20th last refers to four varieties of ragi as recognized by his coolies. These are known, respectively, as "geddey," "karumchurutai," "velleychurutai" and "jaddy." The best yielding variety is perhaps "velleychurutai." There is no difference in the plants, but the seeds vary in colour and quantity according to the variety. A sub-species *E. coracana var. stricta* differs from the type in having the spikes straight, and being of a somewhat larger size.

At the present stage in the cultivation of this crop in Malaya, it is unlikely that attention will be paid to any one variety in preference to another. It seems quite possible, however, that certain varieties may appear better suited for cultivation in this country than others. Should the growing of ragi become more general than at present—there are indications that such may be the case—the isolation of robust and heavy cropping strains, will be work of considerable importance.

Economic Uses.—Ragi is an important food crop in India and it is estimated that $2\frac{1}{2}$ million acres are under cultivation in the Madras Presidency. The total area for all India devoted to this crop averages from $5\frac{1}{2}$ to $6\frac{1}{4}$ million acres. In many parts it is the staple grain, being perhaps the most productive of Indian cereals. In a favourable season an increase of two hundred fold or more is reckoned upon. Ragi is eaten in many districts, chiefly by the poorer classes; it keeps well and is frequently stored in pits for several years in the Mysore country. It may be eaten mixed with rice. Cakes made of ragi-flour are largely eaten in some parts of India. In Darjiling and other places a fermented liquor is prepared from the grain. The percentage of husk to grain is 5 to 6 per cent. by weight. Approximately, 160,000 seeds go to one pound of grain.

CULTIVATION.

Before dealing with the method of cultivation, so far found to be the most satisfactory in this country, it is of interest to touch briefly upon the way ragi is grown in India. Two methods are employed according to the type of land and of rainfall. In districts where an even distribution of rainfall is experienced, amounting to about 50 inches, ragi is grown dry—*i.e.*, with no irrigation. Where there is less, irrigation is resorted to and very large areas of wet or garden ragi are cultivated. In some districts this crop may follow paddy in rotation or even take the place of paddy when the water stored in the irrigation tanks is insufficient for the successful cultivation of the latter.

Dry-land Ragi.—The land is prepared in July and August and the seed sown in September after the heavy rains are received. It may be sown broadcast or drilled at the rate of about 10 pounds per acre. Weeding is carefully attended to and blank spaces filled with transplanted seedlings. The crop is ready to harvest within five months and is cut and stacked in the field to dry for several days. It is threshed by cattle. Ragi is frequently grown as a mixed crop

[1] Growing of Food-stuffs in Malaya. *The Malayan Tin and Rubber Journal*, Vol. V, No. 9, p. 510.

with castor oil, pulses and other grains. The yield is about half that obtained from wet ragi. An average crop may be 1,000 to 1,500 pounds of grain and 4,000 pounds of straw. The straw is not of much nutrient value but in some districts is in considerable favour as a fodder.

This method of growing ragi is being tried on Petaling Hill. There seems no reason why it should not be adopted on the better upland loams of the country. Laterite soil would in all probability be unsuitable.

Wet-land or garden Ragi.—Where abundant supplies of water are obtainable and irrigation is practised, ragi is grown almost throughout the year. Raised beds are made and sown at the rate of about two or three pounds of seed for the acre. The nursery beds are frequently manured and supplied with plenty of water. Before transplanting the seedlings, the bed is allowed to become somewhat dry. The seedlings are ready for transplanting when about nine inches high, usually in 25—30 days from sowing. The land is made into beds and puddled. The seedlings are dibbled into the soil at distances of six inches apart. Frequent hoeings are given, the amount of irrigation varying with the rainfall. The crop matures unevenly and the earheads are cut by hand as they ripen. They are dried in the sun for several days and threshed either by cattle or rolled. The yield varies considerably but 2,000 to 3,000 pounds of grain per crop per acre may be obtained. The fodder is cut and fed green and weighs up to 8,000 pounds per acre. Of recent years the "ridge and furrow" system has become more general. This consists of ploughing the land into furrows and transplanting the seedlings on to the top of the ridges. By this means the water goes a longer way than in puddling and reaches the bottom of the roots of the plants where it is required.

Cultivation in the Malay Peninsula.—Ragi will grow in most soils, other than laterite. Good surface drainage is essential but land that has suffered from wash is unsuitable. The writers have visited a number of estates in Selangor and in the majority of instances, suitable land for the cultivation of ragi has been noticed. Low-lying but well-drained land, frequently found adjoining ravines is suitable. Drainage is essential and should the land be swampy in any places, a system of open drains feeding the main outlet will often bring the land into a condition suitable for the cultivation of ragi. Mr. A. C. Jameson in the paper already referred to believes that there are few estates which have no land on which ragi could be grown.

Seed-beds.—Nursery beds of convenient size should be made on well-drained land. The soil should be well changkolled and brought to a fine tilth. The seed is sown broadcast and lightly covered with fine earth. The beds require no protection. Watering is unnecessary unless the weather be dry. The seeds germinate in five days and grow rapidly. In three or four weeks the seedlings are nine inches high and ready for transplanting.

Preparation of the land.—The area selected is cleared of all weeds and roots. It is then dug over to a depth of one changkol. On large areas, where ploughs and harrows are available, these

implements should be used. On the majority of estates, however, the areas of available land hardly warrant the introduction of implements. Native-made ploughs, might prove economical. The time of sowing is a matter of paramount importance and is influenced by the rainfall. Two crops a year are raised and should be sown so as to harvest during as dry weather as possible. September and March are usually dry in most parts of the country, sowing should be done in May and December to harvest during these months.

Transplanting.—This operation, should, when possible, be carried out during dull weather. The young plants are carefully lifted from the nursery and the ends of the leaves cut off to prevent undue evaporation. The distance of planting should be one foot each way. The plants are dibbled in by hand and firmly surrounded by soil. In a few days they become established and commence throwing out fresh leaves. The flower spikes make their appearance in from six to eight weeks from transplanting. Weeds will probably make their appearance during the period of growth and should be removed by hand picking. Green fly sometimes appears in the centre of the culms. Dull weather appears to favour the growth of these insects and close planting probably has a similar effect.

Harvesting.—The crop shows signs of maturity within five to six months from sowing. The heads ripen unevenly and are cut as they mature. A careful watch must be made for birds and it is necessary to remove the heads immediately upon maturity, otherwise a large amount of grain will be lost. The heads should be well-dried in the sun and threshed out by beating. Woman labour is suitable for this work. The grain, when harvested, does not appear to be attacked by any insect pests, and is said to keep for eating for several years. Observations, however, tend to show that the germinative power deteriorates upon keeping the seed for more than three months. This may be due to damp weather conditions, possibly if the grain were stored in a very dry place, its germinative power might be considerably extended.

Yield.—Estimates of costs of production and yields have recently been placed in the hands of planters.[1] A gantang of ragi weighs seven pounds, and present estimates from various sources indicate a yield of about 300 gantangs per acre per crop. Under good cultivation a higher yield may possibly be expected but it requires further work to substantiate this expectation. It would appear that ragi might be produced on estates in this country at about 13 cents a gantang.

Italian Millet.

Setaria italica.—Tenai (Tamil), *korrah* (Telugu), *navane* (Canarese), *kanguni* (Hindustani).

Description.—A graceful annual grass. Culms erect, three feet high, round and smooth. Roots issue from the lower joints. Leaves narrow, drooping, their margins rough to the touch. Flowers in cylindrical panicles, about seven inches long, nodding at the summit. Seeds small, smooth, varying in colour but commonly yellow.

[1] Food Production Committee, F.M.S. and S.S., Preliminary Circular on Ragi, etc.

Varieties.—A number of minor varieties are met with but the following three appear to be the most important:

(1) *Sentenai*, a red variety bearing long ears,

(2) *Sadaitenai*, ear-heads long and stalks thick,

(3) *Karumtenai*, the black variety.

The variety recently introduced from Madras by the Department of Agriculture has ear-heads of good size and seeds of a pale yellow colour.

Economic Uses.—This millet is cultivated and eaten in many parts of India. The grain is ground and eaten in the form of cakes and porridge. The flour is said to be scarcely inferior to wheat and makes excellent pastry. It forms a pleasant light food when boiled with milk. *Tenai* is grown to a lesser extent than ragi, *cholam* and *kambu* but is well-known to the Tamil cooly, who considers it somewhat of a luxury. The percentage of husk to grain by weight is given as 20 per cent. About 170,000 seeds weigh one pound.

CULTIVATION.

This crop so far has received little attention in Malaya and the writers are unaware of any estate cultivating it on the same scale as ragi. Small areas have, however, been grown at the Kuala Lumpur Experimental Plantation with very satisfactory results. It succeeds best on light rich land and is credited with responding well to the application of manure. Italian millet is usually sown broadcast at the rate of six pounds per acre but it is quite amenable to transplanting from nursery beds, as in the case of ragi, and good results have been obtained by this method. It is a short duration crop and occupies the land for about three months. Seed sown at the Kuala Lumpur Experimental Plantation in the middle of November, 1917, germinated rapidly and the crop was harvested during the third week of the following February. Birds are particularly fond of this grain and must be scared away by some means otherwise a considerable portion of the crop will be lost. The crop matures uniformly and may be harvested at one time.

Yield.—It is not possible to give an estimated yield with certainty, but from calculations made from several small plots a crop of 150 gantangs per acre per crop might be expected on good land. This figure would not be reached on poor land, though when it is considered that the crop matures in three months its utility will be observed.

BULRUSH MILLET.

Pennisetum Typhoideum.—*Kambu* (Tamil), *sajjalu* or *gantelu* (Telugu), *bajra* (Hindustani). Sometimes known as the spiked or pearl millet.

Description.—An erect grass with thick round stems. Culms several, from four to six feet high. Leaves broad, long, the older leaves drooping. The spikes are from six to nine inches in length terminal and cylindrical in shape. Seed, medium size, smooth, of a dull slaty brown colour.

Varieties.—There appear to be several varieties recognized in India. These are distinguished, either by the habit of the plant or by the length of time the plant takes to mature. Work is being done in India in improving the local varieties by seed selection. So far the seed imported appears to be of one kind only and no variation has been noticed.

Economic Uses.—This millet is extensively cultivated in many parts of India and where so grown forms the staple food of the people. The area devoted to this crop in British India is probably well over 10,000,000 acres and in the Madras Presidency alone $3\frac{1}{2}$ million acres is under this crop. The flour is made into cakes and bread and is chiefly eaten by the poorer classes. *Kambu* is readily eaten, when obtainable, by the Tamil cooly in this country. It makes a useful fodder and is used fairly generally in Madras for this purpose. In this country the fodder is unlikely to be much used, though it is intended to try these various millets as cattle fodder when the opportunity occurs. About 111,000 seeds weigh one pound.

CULTIVATION.

Kambu is sown both broadcast and in nursery beds for subsequent transplanting. So far the results obtained here tend to show that the best way of growing this crop is by broadcasting the seed. Light rich soils are the most suitable, but very good growth has also been noticed on heavy land where thorough drainage has been afforded. The land should be prepared as in the case of ragi and the seed sown broadcast at the rate of about eight pounds per acre. The crop is ready for harvesting in $3\frac{1}{2}$ months from sowing. Weeding is usually necessary as little shade is made. The cultural directions given for garden ragi apply when it is desired to grow this crop by means of transplanted seedlings. The heads are placed in the sun to dry and the grain removed by threshing with sticks.

Yield.—The areas under this crop at the Experimental Plantations have so far been too small to prepare an estimate of what yield may be expected. Mr. N. S. Gardner, in the Food Production Committee's Circular already referred to, estimates the yield at 300 gantangs per acre per crop. One gantang measure weighs six pounds. The cost of production of this crop is given as 30 dollars per acre—*i.e.*, 10 dollars less than the same area of ragi, grown from transplanted seedlings.

SORGHUM.

Sorghum vulgare.—*Cholam* (Tamil), *jonna* (Telugu), *juah* (Hindustani).

Description.—A strong growing millet, often over eight feet high, with erect culms. The panicles are branched and very dense. Roots are produced from the axils of the lower leaves. The grain is large, round, and is enclosed in the hard shining outer glumes.

Varieties.—There are a large number of varieties of this millet. These are classed according to their several characters such as colour of grain, duration of growth and height of the plant. Sorghum is very widely grown and local varieties are found in India, Egypt, West Africa, South Africa and parts of the United States of America. According to Sir George Watt, 250 races are recognized

in the Bombay Presidency alone. Numerous varieties are mentioned in a publication issued by the Ministry of Agriculture, Egypt.[1] A large number of varieties have been raised by the various Agricultural Departments in the United States of America.[2]

Economic Uses.—The Tamil cooly appears to regard this grain with less favour than those already mentioned. If eaten as a sole food for any length of time there seems a likelihood of bowel troubles such as diarrhœa and dysentery. The flour is used in making bread and cakes. The crop is grown for two purposes; for grain or for fodder. As a fodder, sorghum is of considerable importance in many parts of India and other tropical countries. Approximately, 16,000 seeds weigh one pound.

CULTIVATION.

Sorghum is an exhaustive crop and should not be grown on the same land for two consecutive seasons. It will grow on the majority of soils in this country but requires deep cultivation to give heavy yields. The land should be thoroughly cleaned of all weeds and deeply changkolled. The seed is sown broadcast at the rate of six to eight pounds per acre. Seeds may be sown in nursery beds and the young seedlings transplanted, this method is, however, not frequently practised. To secure a good yield attention should be given to thinning. When fodder is required, the plants may be allowed to grow thicker. The crop is ready to harvest in from five to six months from sowing of seed. As the plants begin to show their flower heads, soil should be scraped around their roots. Numerous roots issue from the base of the lower leaves and assist not only in obtaining extra nourishment for the plant but in keeping the plant in an upright position when its heavy spikes cause it to be somewhat top-heavy.

Yield.—The yield that may be expected from this crop will depend on the type of land and the amount of cultivation received. The Food Production Committee's Circular, already referred to, gives 300 gantangs as the yield per acre calculated on the yield of sample plots. It is probable that a higher yield than this might be expected on good land under high class cultivation. In India the average production on good land is from 2,000 to 3,000 pounds of grain per acre. One gantang of seed weighs six pounds.

Rice.

Oryza sativa.—This well-known cereal needs no description. With the exception of dry-land rice this crop does not come within the scope of this article. About 130,000 acres are under this crop in the Federated Malay States, of which 15,000 acres are under "dry-padi." To make the Federated Malay States self-supporting it would require over four times the present area devoted to rice to be cultivated. "Dry-padi" is cultivated in this country by two methods—

(1) Ladang or hill-cultivation,

(2) Tenggala or plough-cultivation.

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[1] *Egyptian Agricultural Products*, 1915, No. 1A, *Sorghum vulgare*.

[2] *United States Department of Agriculture, Bulletin* No. 383, New Sorghum Varieties.

Ladang cultivation consists of raising one or two crops of cereals on newly burnt jungle land. This is not a practical method for estates and requires no further mention here. Tenggala cultivation is extensively practised by Malays on the alluvial soils that occur on the low land adjoining large rivers. The banks of the Pahang River are much used for this form of cultivation. This method of cultivation is, however, quite suitable for flat lands with a high water-table. "Notes on the production of dry-land rice in the Federated Malay States with suggestions concerning the temporary cropping of estates" have recently been published by the Department of Agriculture. This publication is also in the form of a pamphlet and can be obtained on application.

Maize.

Maize or Indian Corn.—Zea mays, jagong (Malay), *makka cholam* (Tamil).

Maize is an important stable article of food in tropical and sub-tropical countries and is becoming popular in temperate climates. It is held to be superior in nutriment to barley, rye and buck-wheat but is not considered so wholesome as wheat. The exclusive use of maize for either man or beast is not recommended, it should be used in conjunction with other foods. The ripe corn is used for the production of flour and meal and the green cobs form an excellent vegetable. Maize as a food-stuff is of little importance to the Tamil coolies and is not likely to take a position, in this respect, equal to that of millets.

The world's production of maize, according to Mulhall, averages over 2,000,000,000 bushels, the United States heads the list with 72,390,000 acres, yielding 1,412,000,000 bushels. The canning of Indian corn is reported as becoming an important industry.

Maize requires moderately rich soils and may be grown two or three successive seasons on the same plot. In this country it probably thrives best in land recently brought under cultivation which has a good proportion of humus in the soil and is friable in nature. Land which has suffered to any extent from surface wash is unsuitable.

A thorough preparation of the land is considered essential for the production of good maize crops. Tillage should be carried out to a depth of about eight inches and the surface brought to a fine tilth, this is best done by harrowing.

The seed is sown broadcast after rain, on a well-prepared surface, at the rate of 10 to 15 lbs. per acre, as a sole crop, and lightly turned under. The seed may also be dibbled in at distances of six inches in rows which are three feet apart and thinned out, when the plants are well established, to 18 inches in the row. The depth of planting the seed has a considerable bearing on the period of germination, formation of stalk and production of crop. A depth of one inch can be recommended. It might here be mentioned that the land should be thoroughly free from weeds previous to sowing. After cultivation is also an important factor and has a considerable bearing on the yield. The land should be thoroughly weeded prior to the seedlings making their appearance above ground, subsequent weeding may be conducted when the plants have been thinned out, care being taken not to disturb or break off any of the roots.

The crop takes three to six months to mature, depending on the variety and the conditions under which it is grown. If the cobs are required as a vegetable they are pulled while green, otherwise the cobs are left until the leaves surrounding them become shrivelled. The general practice of harvesting here is to pull the cobs and cart them to a store where they are husked. The amount of labour required in harvesting a large maize crop is considerable. The cob is in an upright position when growing but bends over as it becomes ripe. It is stated that 75 lbs. of cob is equal to a bushel of 56 lbs. weight of shelled corn. Proper drying and storage of the freshly harvested crop are of very great importance. The weevil is the most common pest and in this country it seems almost impossible to keep the grains in store for any length of time, free from weevil attack. Air-tight bins, with an application of bisulphide of carbon on rags placed amongst the grain is reported a satisfactory preventative. When the crop is harvested the maize stalks should be turned under.

THEORY OF LATEX COAGULATION.

By G. Stafford Whitby.

IN a recent paper Barrowcliff[1] has brought forward strong evidence in support of the view that the agency responsible for the natural coagulation of Hevea latex is enzymic. He has shown further that, not only natural coagulation, but also coagulation resulting from the addition of acetic acid appears to be due to enzyme activity. It appears that the function of the acid in acetic acid coagulation is to activate a coagulating enzyme. Barrowcliff found that latex which had been sterilised by running it into an equal volume of water maintained at boiling point was no longer coagulable by acetic acid but became so if treated with a few drops of fresh latex.

The present writer has confirmed this suggestive observation.

> Latex (rubber-content 40 per cent.) was run slowly into 2 volumes of water maintained between 87° C and 90° C. When the latex was cool acetic acid in the proportion of 4 c.c. N/2 solution per 100 c.c. was added. No coagulation occurred. A portion of the latex to which a few drops of unsterilised latex had been added or a portion of the original unheated latex similarly diluted coagulated normally with the same proportion of acid.
>
> Even after 24 hours the sterilised latex containing acetic acid had not coagulated, although a few flocks had separated. Even after 4 days the latex was quite fresh in smell and no clot had formed; the rubber present was on the surface in the form of a "cream."

The conclusion to which this observation points—*viz.*, that the function of acetic acid in the ordinary process of latex coagulation is to activate an enzyme—resolves, as is pointed out in what follows, certain anomalies which the view that the separation of rubber from its colloidal emulsion by acid is a physico-chemical phenomenon in the ordinary sense involved.

Without leaving out of mind the warning of Humphrey Davy "The substitution of analogy for fact is the bane of chemical philosophy; the legitimate use of analogy is to connect facts together and to guide to new experiments," it may be agreed that consideration of the question as to whether the coagulation of cow's milk by natural souring or the addition of acids on the one hand or by rennin on the other hand offers a better analogy to the coagulation of latex can serve a useful purpose in focussing facts bearing on the theory of latex coagulation.

The object of this paper is primarily to compare in certain aspects the coagulation of latex with the coagulation of cow's milk and, *en passant*, to record a number of experimental results. Barrowcliff [1] has already set out the general analogy between latex coagulation and the coagulation of milk by rennin. In the present paper a closer examination of certain aspects of this analogy will be made.

1. *Coagulability of sterilised milk.*—Boiled milk can be coagulated by added acid in the same way as unboiled milk. Repeating with cow's milk the sterilisation procedure which was followed by Barrowcliff with latex, it was found that, in contradistinction to latex, the milk was coagulable with acetic acid.

2. *Critical concentration of acid for milk coagulation.*—In the coagulation of milk by added acetic acid or added lactic acid there is what may be called a critical concentration of acid. Below this

concentration no coagulation occurs. Even when the acid added is only 10 per cent. less than this quantity no coagulation occurs, but when the critical amount or more is added *immediate* clotting takes place.

> A sample of cow's milk was divided into 50 c.c. portions and treated with N. Acetic and with N. Lactic acids. 3.5 c.c. of either acid produced immediate clotting. 3.0 c.c. of either acid failed to produce clotting.

This behaviour of milk stands in very marked contrast to the behaviour of Hevea latex towards increasing amounts of added acid. In the case of latex there is no critical concentration at which immediate clotting occurs and below which no clotting is obtained: there is a wide range over which acid concentration can be varied and great differences in the rapidity with which coagulation can be brought about.

3. *Anti-coagulating effect of a deficit of acetic acid in milk.*—A result in regard to the effect of acetic acid on cow's milk which stands still more strikingly than the foregoing in contrast to the effect of added acetic acid on Hevea latex is that an amount of acetic acid below the critical amount, not only fails to produce coagulation, but has a pronounced anti-coagulating effect.

> To a sample of milk which could be readily clotted by the addition of 8 c.c. of N. Acetic acid per 100 c.c. 4 c.c. of N. acetic acid were added. No coagulation occurred, and the milk remained liquid for eight days and clotted only on the 9th day. A control sample of untreated milk clotted after two days. Temperature, 20° C.
>
> Even lactic acid, added to milk in amounts less than the critical amount was found to have a certain anti-coagulating effect; although its effect was by no means so marked as the effect of acetic acid. Milk to which lactic acid had been added in an amount 20 per cent. less than that necessary for immediate clotting underwent coagulation at a somewhat later time than an untreated control.*

In the case of Hevea latex acetic acid in amounts less than the amount necessary for rapid coagulation has no anti-coagulating effect and does not fail to produce coagulation; the only result of diminishing the amount of acid added is to render the coagulation slower. In the case of milk, amounts of acetic acid smaller than the amount necessary for rapid coagulation may, as just mentioned, have such a marked anti-coagulating effect that they preserve the milk in a liquid condition for a week or longer.

The action of acetic acid when present in suitable amount in preventing the coagulation of milk is due presumably to an unfavourable effect on the growth of the lactic acid bacterium. The retardation of coagulation by a suitable proportion of lactic acid may be similarly regarded. It might at first appear that the addition to milk of part of the lactic acid which it is necessary to have present in order that clotting may occur would hasten clotting, since a smaller bacterial production of acid is called for than in untreated milk. That added lactic acid does not hasten clotting must be considered as due to the difficulty which the presence of lactic acid places in the way of the growth of the lactic acid bacterium.

Comparing the case of latex with that of milk as regards the effect of added acids on the growth of bacteria: it is clear that acetic acid also exercises a considerable anti-bacterial effect in Hevea

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* The anti-coagulating effect on cow's milk of amounts of added acid below the amount necessary for coagulation does not appear to have been previously recorded.

latex, as is shown by the much smaller tendency to decomposition by bacteria (producing gas and putrefaction) of coagulum produced by acetic acid than of coagulum produced by natural change: as is also shown by the fact that the larger the amount of acetic acid employed for coagulation the smaller is the tendency of acetic acid coagulum to suffer bacterial decomposition, and as is shown by a variety of other facts which are encountered in factory practice and laboratory work with raw rubber. And yet, in contrast with the case of milk, acetic acid has no anti-coagulating effect.

The weight of this consideration tells against the bacterial hypothesis of latex coagulation. It may of course be urged that, although acetic acid is unfavourable to the growth in latex of most species of bacteria, it is possible that the bacterium or bacteria responsible for natural coagulation are not unfavourably affected. Gorter and Swart,[2] it may however be observed, who accept the bacterial hypothesis, appear specifically to view the lactic acid bacterium as the chief agency in natural coagulation.

4. *Time factor in the formation of a clot.*—As already pointed out, the clotting of milk by added acid is a practically instantaneous process, whereas time occupied by the formation of a clot in latex may, by suitable adjustment of the amount of acid added, be varied over a period of from, say, 3 minutes to 8 hours. Not only is there, negatively, as the above observation indicates, a failure of analogy between latex coagulation and the acid coagulation of milk in regard to the time factor, but there is, positively, a close analogy between the effect of acids on latex coagulation and their effect on the coagulation of milk by rennin, as the following results of Gerber show.

Working at 20° C, with 5 c.c. of milk plus a rennin preparation in each test, the following figures show the effect of added HCl (and of $CaCl_2$) on the rapidity of coagulation.[3]

	With 1.92 c.c. of the rennin prepn.	With .24 c.c. of the rennin prepn.
Control	34 m. 35 s. ...	85 m. 40 s.
2.5 millimols. HCl per l. milk ...	10 m. 25 s. ...	41 m. 05 s.
10 millimols. HCl per l.	2 m. 25 s. ...	15 m. 25 s.
(2.5 millimols. $CaCl_2$	6 m. 56 s. ...	33 m. 50 s.
10 „ „	1 m. 35 s. ...	12 m. 00 s.)

Later results obtained at 40°C are as follows[4]:

5 c.c. of milk plus .5 c.c. of the rennin preparation in each case.

Millimols. HCl per litre.	Time for coagulation. Raw milk.	Boiled milk.
	m. s.	m. s.
0	29.50	32.10
0.875	25.00	20.15
1.75	20.10	13.30
3.50	14.40	9.10
7.0	8.20	4.40
10.5	6.10	2.20
14	4.50	1.50
17	4.20	.50
20	4.05	Coagd. without
23	4	enzyme.
26	Coagd. without enzyme.	

Similar results were obtained with butyric and other organic acids. No corresponding exact series of observations on the variation in the time required for the coagulation of latex with the amount of acid added are available, but that there is an increase in the rapidity of coagulation with increase in the amount of acid above minimal quantities is universally recognized.*

Consideration of the time factor in the formation of the clot links latex coagulation much more closely to the coagulation of milk by rennin than to its coagulation by acid in the absence of rennin.

Even in the absence of all other considerations, the slowness with which coagulation takes place in ordinary plantation practice would seem to afford a strong presumption that the coagulation of latex under the influence of added acid is not a direct physical phenomenon but involves the activity of an enzyme.

5. *Acid concentration for natural coagulation.*—In the case of the coagulation of milk by the addition of acid or by natural souring the occurrence of coagulation appears to depend substantially upon the presence of a certain concentration of acid. When, as a result of natural souring, the acidity has reached a certain point, clotting occurs. According to Van Slyke and Hart,[5] under ordinary conditions of souring at 20° C "we can expect that . . . milk will coagulate . . . when the lactic acid (produced by souring) reaches .6—.7 per cent." The critical concentration of added acid which is necessary in order to produce clotting artificially is of the same order as the concentration necessary for natural souring.

In the case of latex the development of acidity has not been studied as closely as in the case of milk, but it seems clear that, in contradistinction to the case of milk, the natural coagulation of latex is not a simple function of its acidity. It was shown by the writer some years ago[6] that the natural development of acidity in latex and the occurrence of natural coagulation do not take place *pari passu*.

(*a*) Undiluted latex collected in the morning had set to a solid mass of natural coagulum at 6 p.m., and its acidity was equivalent to .048 per cent. acetic acid—an amount much smaller than that which it would be necessary to add in order to bring about acetic acid coagulation in the ordinary way.

(*b*) Some of the same sample of latex was diluted with 5 volumes of water and allowed to stand overnight. On the following morning it was found to have developed acidity equivalent to .30 per cent. acetic acid but to be uncoagulated. Similarly-diluted fresh latex underwent rapid coagulation when treated with this proportion of acid.†

The fact thus shown that the amount of acidity engendered naturally in latex may be very greatly in excess of that which it would be necessary to add to fresh latex in order to produce

* Regarding the inhibition of coagulation by extremely high proportions of acetic acid, compare section 10 "Significance of the gap."

† It may be noted that the observations (*b*) indicate either that the acid which is produced in the course of the natural change of latex does not activate the hypothetical enzyme as effectively as acetic acid, or, as is more probable, that the growth of organisms in latex allowed to undergo natural change produces bodies that exercise an unfavourable influence on the activity of the enzyme.

coagulation reveals a further failure of analogy between latex coagulation and the acid coagulation of milk.

It is also worthy of remark, as indicating that the coagulation of latex is not a simple function of its acidity, that the coagulating effect of the addition of serum to latex does not appear to be proportional to the acidity of the serum.

Serum was taken from a bulk coagulating vessel in a factory in which the latex had been coagulated by acetic acid and allowed to stand overnight. The acidity of the serum was equivalent to .28 per cent. acetic acid. It gave the following results when added to fresh diluted latex (rubber-content, 15.78 per cent.).

(*a*) 25 c.c. serum to 100 ccs. latex produced only very partial coagulation overnight. Dry weight of coagulum, 10.85 gms. Weight of rubber remaining uncoagulated, 4.93 per cent.

(*b*) 50 c.c. serum to 100 ccs. latex produced comparatively satisfactory but not absolutely complete coagulation. Weight of rubber remaining uncoagulated, .3 gms.

The amount of serum used in (*b*) represents an amount of acid approximately twice that which it would be necessary to add in the form of a solution of pure acetic acid in order to secure complete coagulation.

The number of experiments made on the effect of old serum on fresh latex was not extensive, but it appeared that the behaviour of different samples of serum varies considerably, indicating the presence of other factors (including anti-coagulating ones) than acidity. Gorter and Swart[2] also encountered a lack of constancy in the effect of samples of serum on coagulation, and they did not find the addition of serum to latex to have an effect in assisting natural coagulation such as, on the assumption that the natural coagulation of latex is essentially dependent upon its acidity, they anticipated.

6. *Nature of the clot.*—Considering the outward character of the clot, particularly as regards coherency: it is clear that the clot produced in milk by enzymic action is more analogous to the ordinary rubber coagulum than is the clot produced in milk by natural or added acid: that the ordinary rubber coagulum resembles the coherent clot (junket) produced by rennin rather than the floccular clot which is first produced in milk by souring or the addition of acids.

Incidental to the question of the nature of the clot it may be pointed out that the coagulum produced in latex by certain agencies is of a non-coherent character more analogous to the clot produced by the acid coagulation of milk and may reasonably be regarded as being caused by the direct physical action of the agencies in question without the intervention of a coagulating enzyme. In these cases the clotting appears to be further analogous to the acid coagulation of milk in being immediate. Such cases are as follows.

(*a*) *Coagulation by heat.*—In the course of some observations on the influence of heat in bringing about the clotting of latex, it was found[6] in general that samples of latex possess a comparatively sharply defined curdling temperature. The rubber which separates when the latex reaches this temperature is not in the form of a single, coherent coagulum, but is floccular.* This type of coagulum is analogous to the coagulum produced by the acid coagulation of milk.

* It should be remarked that a floccular rubber coagulum can usually be converted into a coherent mass by pressure, by continued heating, or sometimes by prolonged standing.

As in the case of milk, a comparatively small amount of acid has a marked effect in assisting clotting by heat.

About .2 per cent. of acidity is sufficient to bring about the coagulation of milk on boiling.[7] Duclaux found that even carbon dioxide influenced the coagulation.

In the course of the observations on latex mentiond above, undiluted latex, which clotted to a mass of discrete particles at about 63° C (by prolongation of the heating to 75° the mass could be made to cohere to a considerable extent) suffered a reduction of about 8° in its curdling temperature when treated with CO_2. Samples of diluted latex which could be subjected to boiling without undergoing coagulation became coagulable by heat at comparatively low temperatures if allowed to stand for some time in order to permit the development of natural acidity.

(*b*) *Coagulation by tannic acid and certain other protein precipitants.*—Coagulation by tannic acid is distinguished from coagulation by acetic acid by (a) the non-coherent character of the coagulum, (b) the immediacy of coagulation. In these respects there is a broad resemblance of coagulation by tannic acid to the acid coagulation of milk.

It was observed with tannic acid that there was a marked tendency for clotting to take place instantly at the point of entrance of the tannic acid solution into the latex. It was further observed that in order to secure clean coagulation with tannic acid it was necessary to employ an amount approximating to that necessary to throw down all the precipitable protein in the latex. From the serum of latex coagulated, in the usual manner, with acetic acid, a heavy precipitate can be obtained by the addition of tannic acid. When employing tannic acid for coagulation the amount required in order to produce clean coagulation was such that addition of a further quantity of tannic acid to the serum would yield little or no precipitate.

Quantities of 100 c.c. of latex containing 12.4 per cent. rubber were treated with a 10 per cent. solution of tannic acid. (a) 1 c.c. (b) 2 c.c. (c) 4 c.c. (d) 6 c.c. On examination after 4½ hours, (a) was quite liquid; (b) was somewhat thick but uncoagulated; in (c) and (d) clots had formed but were non-coherent and could readily be picked to pieces with the fingers. On examination next morning—(a) showed signs of putrefaction and had undergone natural coagulation; its serum gave a considerable precipitate when treated with a solution of tannic acid; (b) was free from putrefaction, but the rubber had separated only in totally non-coherent floccular form and could not be lifted out by hand; (c) and (d) showed no signs of putrefaction; the coagula could be lifted out of the serum but could be readily picked to pieces. The serum from (d) gave hardly any precipitate when tannic acid was added to it.

The case of tannic acid as a coagulant would appear to be worth further study.

Non-coherent coagula were also obtained with aqueous extracts of mangrove bark and of gambier. Flocculant coagula were obtained with sodium sulphate in warm solution and with phosphotungstic acid, but the effect of these reagents was not examined with any closeness.

In addition to the above aspects of the matter, consideration of which appears to tell with some directness in favour of the enzymic hypothesis of latex coagulation, the following aspects seem to be worth setting forth.

7. *Influence of calcium salts.*—That calcium chloride is capable of leading to the coagulation of latex was recorded some years ago[6]. Recently Campbell[8] and Barrowcliff[1] have stressed the peculiar significance of calcium salts in regard to the coagulation of latex and are disposed to consider that calcium salts, which play an important rôle in the coagulation of other natural fluids (milk[10] and blood) are of special importance in the coagulation of latex. Eaton[9], who holds that the cause of the natural coagulation of latex is bacterial, suggests that the influence of soluble calcium salts in promoting natural coagulation is due to the presence of calcium being favourable to certain anærobic organisms, possibly by combining with proteins in the latex and thus preventing formation from the proteins, by decomposition, of alkaline bases with an anti-coagulating effect. There does not, however, seem to be any analogy for this suggestion either in the coagulation of blood or in the acid or enzymic coagulation of milk.

On the view, however, that latex coagulation is an enzymic process, there appears to be, as the results of Gerber (quoted earlier under section 4) on the activation of rennin by calcium chloride indicate an analogy between the action of calcium chloride on latex and its action on the enzymic coagulation of milk.

Even now, after many workers have devoted attention to the subject, the rôle of calcium salts in the coagulation of blood and milk is far from being conclusively demonstrated; and it is too early to expect the nature of their special function (if any) in latex coagulation to be revealed.

> The following observation may perhaps be taken as indicating that the calcium ion has a special relation to latex coagulation and may be recorded here.
>
> A solution of sodium bisulphite was found to have a definitely anti-coagulating effect on latex, while a solution of calcium bisulphite was found to have a strong coagulating effect.

8. *Effect of bactericides and of enzyme paralysors.*—Barrowcliff[1] points out that the natural coagulation of latex is not inhibited or retarded by toluol or by thymol: bactericides which are usually harmless to enzymes. The present writer can confirm this result in the case of thymol. A similar result was also obtained with chloroform water.

> Latex to which amounts ranging from 2 per cent. to 20 per cent. of a cold-saturated solution of thymol had been added or to which 10 per cent., 50 per cent., or more chloroform water had been added underwent anærobic natural coagulation normally.

Barrowcliff points out that the natural coagulation of latex is on the other hand prevented by an agent such as hydrocyanic acid which is well recognized to be an enzyme paralysor. The present writer had obtained a similar result with potassium cyanide. It has also been found[6] that hydrogen sulphide, although acidic, retards or inhibits coagulation.

9. *Influence of oxygen on coagulation.*—The natural coagulation of latex is generally recognized as being favoured by the exclusion of air. The natural souring of milk is stated to be favoured by exposure to air. It was found by Richet[11] that the fermentative action was greater in milk kept in an ordinary flask than in milk

kept in a long tube (in which a minimal surface was exposed to the air); the amount of acidity found in the latter circumstances being only 70 per cent. (in another experiment, 65 per cent.) of that found in the former circumstances. In apparent contrast to the case of milk the natural coagulation of Hevea latex "is not dependent upon the surface exposed; coagulation takes place as quickly and completely in a tall narrow, cylinder as in a flat, open dish".[6]

10. *Possible significance of the "gap".*—Barrowcliff[1] points out that, on the view that an enzyme is concerned in latex coagulation, the fact that hydrochloric acid in certain comparatively high concentrations fails to coagulate latex may be due to the destruction or paralysis of the enzyme by this concentration of acid. Assuming the case to be as thus suggested, it may be further pointed out that at still higher concentrations the acid would appear to have a direct clotting effect. It has been shown[6] that on adding increasing quantities of hydrochloric acid to samples of latex a point is reached comparatively soon at which no coagulation occurs, but that on continuing to increase the amount of acid added a further point is reached at which coagulation again begins to take place. There is, as it were, a gap over which no coagulation occurs. The position of this gap was found to be approximately from a concentration of hydrochloric acid corresponding to 3 c.c. 1 in 10 HCl per 100 ccs. of 10 per cent. latex to 10 ccs. 1 in 10 HCl per 100 ccs. 10 per cent. latex.

More recently the author has observed the existence of a similar gap in the case of nitric acid.

A sample of diluted latex containing 12.0 per cent. rubber gave the following results with nitric acid. 100 cc. taken each time.

1.5 cc. 10 per cent. nitric acid produced rapid and complete coagulation. With 2 cc. coagulation was only very partial. On the following morning the serum was milky, the coagulum was soft and had not risen to the surface. Dry weight of coagulum, 9.42 gms.; weight uncoagulated, 2.60 gms. or 21.6 per cent. With 3 cc. and with 5 cc. coagulation failed to occur. With 7.5 cc. coagulation was only very partial. With 10 cc. coagulation was practically complete. With 20 cc. or more coagulation was perfectly clean.

The addition of a solution of tannic acid to the samples in which nitric acid had failed to bring about coagulation produced coagulation.

The position of the gap, over which no coagulation or only very incomplete coagulation occurs, is, it will be noticed, approximately the same in the case of nitric acid as it was found to be in the case of hydrochloric acid.

Eaton and Grantham[12] have suggested that bacterial action is the cause of the natural coagulation of Hevea latex. Barrowcliff[1] makes certain criticisms of the experiments upon which this suggestion was based.

In relation to Eaton and Grantham's Experiment I, in which latex was heated for 1–2 mins. in a steam autoclave at 140–150° C and found to remain unchanged afterwards if kept in a plugged flask but to coagulate in 24 hours if exposed to the air, the following points may be remarked.

Undiluted latex has been found usually or always to suffer clotting if subjected to a temperature of 75° C. Had the latex in Eaton and Grantham's experiment actually assumed a temperature approaching 140–150°, it seems probable that the heat would have brought about clotting.

> The experience of the present writer has been that, in order to withstand a temperature of even 100° without suffering coagulation, latex requires to be diluted considerably with water, and that on subsequent exposure to the air coagulation does not take place for several days in latex which has been sterilised by boiling. In respect to their Experiment I Eaton and Grantham state that coagulation was "nearly complete" after 24 hours in the latex which had been sterilised and then exposed to the air and that the unsterilised control coagulated "almost completely" in 24 hours. They state, however, when generalizing their observations, that changes take place in latex sterilised and then exposed to the air much more slowly than in unsterilised latex. As Barrowcliff remarks, there may have been some circumstance in Eaton and Grantham's Experiment I leading to an anomalous result.
>
> In Eaton and Grantham's Experiment II, in which latex was heated in an autoclave at 90—100° C, the coagulating agency, whether enzymic or bacterial, admittedly was not destroyed; and the experiment does not appear to afford any definite evidence as to the nature of the agency.

As Eaton and Grantham's paper recognizes, the experiments recorded in it prove only that bacterial change is capable of bringing about the coagulation of latex which has been sterilised and do not demonstrate the nature of the agency responsible for the coagulation of fresh latex. That bacterial action ultimately brings about coagulation in latex which has been subjected to sterilisation and subsequently exposed to the air was signalized at the time that the enzymic hypothesis was suggested[6]. (In this connection it may be remarked that a noticeable difference was observed between natural coagulation in fresh latex and the coagulation ultimately produced in sterilised latex by bacterial action, in that in the latter case the rubber tends first to separate in a non-coherent or even in a slimy form.) The experiments of Eaton and Grantham cannot be regarded as inconsistent with the view that the agency responsible for the initial setting of fresh latex is enzymic: a view for which, as the observations of Barrowcliff and the considerations advanced in this paper reveal, there is strong circumstantial evidence. An experimental collation of the observations of different workers on the sterilisation of latex and its subsequent coagulation would, however, seem to be desirable.

Eaton[9] adduces in support of the view that the cause of the natural coagulation of Hevea latex is bacterial results recently obtained by Denier and Vernet[13] in an examination of the bacterial flora of samples of latex. These workers recognized in various samples of Hevea latex twenty-six species of bacteria in all. The flora of different samples of latex showed variations, but a bacterium generally present was one, whose characters are described in some detail, which produced gas and acid when grown on agar containing sugar.

There is no proof that this bacterium is a veritable cause of coagulation in latex. It is stated that when the bacterium is sown in vessels of latex it allows of coagulation being obtained in 24 hours. It is almost certain, however, that the latex in question would have coagulated in 24 hours without the addition of the bacterium.

These authors' standard of coagulation does not seem clear. They recognize that aerobic bacterial activity, which flourishes at

the surface of latex exposed to the air, leads to the production of an alkaline scum and has an unfavourable effect on the completeness of coagulation, and they consider that the salient function of sugar in assisting the completeness of coagulation is that of giving preference to the growth of organisms other than those concerned in this aerobic activity. Yet they do not look upon natural coagulation in latex which is exposed to the air and to which no addition has been made as having occurred until about 48 hours has elapsed and the surface has assumed a yellow colour. It is usual and would appear to be much more satisfactory to consider natural coagulation as having occurred when the latex (undiluted) has become a solid mass, about 12 hours after collection; for, although coagulation is not then complete, it is substantially so, and in the succeeding period the effect of the bacteria which flourish at the surface introduces a secondary factor, which acts in an anti-coagulating sense.

In the case of latex sown with the bacterium employed by Denier and Vernet, coagulation, it is stated, occurred in 24 hours; but presumably an alkaline slime developed as in untreated latex, and, in the absence of any definite criterion of the occurrence of coagulation the apparent reduction in the time required for coagulation from about 48 hours to 24 hours cannot be regarded as affording proof that the bacterium aided coagulation, particularly when it is remarked that although, as is stated, the introduction of the bacterium allowed "complete" coagulation to take place in 24 hours, it was found advisable both to add sugar and to exclude air in order to obtain "perfect" results.

The results of Denier and Vernet do not appear to supply any support to the bacterial hypothesis of latex coagulation.

CONCLUSIONS.

It is concluded that, so far as present knowledge goes, the coagulation of cow's milk under the influence of rennin offers a much closer analogy to the coagulation of Hevea latex than does the clotting of milk by added acids or natural souring, and that the salient agency in latex coagulation is probably enzymic.

It is concluded that the initial formation of the clot in fresh latex allowed to undergo natural change is probably due to enzymic action and that the same agency, activated by acids, is probably responsible for acetic acid coagulation. Bacterial action is viewed, in regard to the occurrence of natural coagulation in latex, as a secondary factor only. The possibility of the natural acidity acting to a certain extent as an activator of the hypothetical enzyme is not absolutely excluded.

It is recognized that in addition to coagulation taking place ordinarily under the influence of an enzyme, there may occur under special conditions coagulation of other types—*viz.*, the delayed coagulation in latex which has been subjected to sterilisation, due to the ultimate putrefactive decomposition of the latex; the non-coherent coagulation produced by heat or by protein precipitants, particularly by tannic acid and not improbably the coagulation produced by hydrochloric and nitric acids on the far side of the "gap" which is associated with the addition of increasing quantities of these acids to latex.

Very much remains for investigation in connection with latex coagulation. It is believed that at the present stage the enzymic hypothesis of coagulation affords the best explantion of the facts.

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[1] *Jour. Soc. Chem. Ind.*, *37*, 48T (15th Feb., 1918)

[2] See this Bulletin, *V*, 481 (July, 1916)

[3] Compt. rend., *147*, 1320 (1908)

[4] *Ibid.*, *148*, 56 (1909)

[5] *Amer. Chem. Jour.*, *32*, 145 (1904)

[6] Seventh Internat. Congress Appd. Chem., *25*, 597; also Koll. Zeit., *12*, 147 (1912)

[7] Thorner, *Chem. Zeit.*, 1891, 1108; Rideal, *Lancet*, 1900, I, 229; Richmond, *Analyst*, (1900), *35*, 121.

[8] *Jour. Chem. Ind.*, *36*, 274 (15th March, 1917)

[9] This Bulletin, *VI*, 158 (Dec., 1917)

[10] Bosworth, *Jour. Biol. Chem.*, *15*, 231, (1913) may be consulted for a recent view of the importance of calcium salts in the coagulation of caseinogen by rennin.

[11] Compt. rend., *88*, 750 (1879)

[12] This Bulletin, *IV*, 26 (Nov., 1915)

[13] Compt. rend., *165*, 123 (16th July, 1917)

CATALOGUE OF FRUITS SUITABLE FOR CULTIVATION IN THE MALAY PENINSULA.

By J. N. Milsum.

THERE are a large number of fruits suitable for cultivation in the Peninsula, both indigenous and exotic. Mr. I. H. Burkill in his paper on food-crops [1] at the Agricultural Conference last year, gave a list enumerating fifty-nine different fruits. There are, however, many others met with and it is thought that a list with scientific and vernacular names of those known may be of interest. The list is divided to show the varying importance of the different kinds. Mention is also made of those fruits suitable only for growing on the hills in Malaya. Such fruits are of little importance at the present time but when the hills are more opened up, it is to be expected that they will receive more consideration. The writer is at present engaged in the production of a practical bulletin on Fruit Cultivation in Malaya; this will be published as soon as possible. In the meantime it is hoped that this list will stimulate interest in the cultivation of fruits—a branch of agriculture that has been very much neglected in this country of recent years.

It is recognized that the following list may not be complete and the writer invites any comments or additions from those interested in the cultivation of fruit in Malaya.

Principal fruits for cultivation in the Malay Peninsula.

Natural order.	Scientific name.	English name.	Malay name.
Anonaceae ...	Anona muricata ...	Soursop ...	Durian belanda
	„ squamosa ...	Custard apple ...	Buah S'ri Kaya
	„ reticulata ...	Bullock's heart...	Nona kapri
Guttiferae ...	Garcinia Mangostana ..	Mangosteen ...	Buah Manggis
Malvaceae ...	Durio Zibethinus ...	Durian ...	Durian
	Hibiscus Sabdariffa ...	Rozelle ...	
Oxalideae ...	Averrhoa bilimbi ...	Blimbing ...	Belimbing buloh
	„ carambola ...	Carambola ...	„ batu
Rutaceae ...	Citrus decumana ...	Pomelo ...	Limau Betawi or Limau besar
	„ aurantium ...	Orange ...	Limau manis
	„ acida ...	Lime ...	„ kapas or Limau asam,
	„ limonum ...	Lemon ...	etc.
Burseraceae ...	Canarium commune ...	Kenari nut ...	Kenari
Meliaceae ...	Sandoricum indicum ...	Sentol ...	Sentul
	„ radiatum ...	...	Kechapi
	Lansium domesticum ...	Langsat ...	Langsat
	„ „ var; duku	Duku ...	Duku
Sapindaceae ...	Nephelium lappaceum...	Rambutan ...	Rambutan
	„ mutabile ...	Pulasan ...	Pulasan

[1] *Agricultural Bulletin, F.M.S.*, Vol. V, p. 406

Principal fruits for cultivation in the Malay Peninsula—(cont.)

Natural order.	Scientific name.	English name.	Malay name.
Anacardiaceae ...	Mangifera indica ...	Mango ...	Empelam or mempelam
	Bouea macrophylla ...	Kundangan ...	Kundangan
	„ microphylla ...	Rumeniya ...	Rumeniya
	Anacardium occidentale	Cashew-nut ...	Gajus
Myrtaceae ...	Psidium gujava ...	Guava	Jambu biji
	„ acre ...	Little guava ...	
	Eugenia malaccensis ...	Malay apple ...	Jambu bol
	„ Jambos ...	Rose apple ...	„ kelampok
	„ aquea ...	...	„ ayer
	„ uniflora ...	Pitangi	Chermai belanda
Passifloreae ...	Passiflora laurifolia ...	...	Buah susu
	„ quadrangularis	Grenadilla ...	Timun hutan or Timun belanda
	Carica papaya	Papaya	Betek
Sapotaceae ...	Achras sapota	Sapodilla ...	Chiku
Ebenaceae ...	Diospyros discolor ...	Butter fruit ...	Buah mantega
Laurineae ...	Persea gratissima ...	Avocado pear ...	
Urticaceae ...	Artocarpus integrifolia	Jack fruit ...	Nangka
Euphorbiaceae ...	Baccaurea Motleyana...	...	Rambai
Scitamineae ...	Musa spp;	Plantain ...	Pisang
Bromeliaceae ...	Ananassa sativa ...	Pine-apple ...	Nanas
Palmae	Cocos nucifera	Coconut	Kelapa

Fruits of less importance.

Natural order.	Scientific name.	English name.	Malay name.
Dilleniaceae ...	Dillenia indica	...	Simpoh
Nymphaeaceae ...	Nelumbium speciosum	Lotus	Seroja
Bixineae ...	Flacourtia cataphracta	...	Rokam
	„ Rukam ...		
	„ inermis ...		
Guttiferae ...	Garcinia Xanthochymus		
	„ atroviridis ...	...	Assam Gelugar
Malpighiaceae ...	Malpighia urens ...	Barbados cherry	
Rutaceae ...	Citrus Hystrix	...	Limau Puru
	„ medica	Citron	„ batu
	Triphasia aurantiola ...	Lime berry ...	„ Keah
	Feronia Elephantum ...	Wood apple ...	
	Aegle marmelos ...	Bael fruit ...	Bela
Ampelideae ...	Vitis vinifera	Grape vine ...	
	„ Marteni	Saigon vine ...	
Rhamneae ..	Zizyphus jujuba ...	Jujube	Bedara China
Sapindaceae ...	Nephelium malaiense ...	...	Mata Kuching
Anacardiaceae ...	Mangifera caesia ...	...	Binjai
	„ kemanga ...	..	Kemang
	„ odorata ...	...	Kuwini
	„ lagenifera ...	...	Lanjut
	„ foetida ...	Bachang ...	Bachang
	Spondias dulcis ...	Otaheiti apple ...	
	„ mangifera ...	Hog plum ...	
Leguminosae ..	Tamarindus indicus ...	Tamarind ...	Asam jawa
	Inocarpus edulis ...	Otaheiti chestnut	
Rosaceae... ...	Chrysobalanus Icaco ...	Coco plum ...	

Fruits of less importance—(cont.)

Natural order.	Scientific name.	English name.	Malay name.
Combretaceae ...	Terminalia catappa ...	Bengal almond...	Ketapang
Myrtaceae	Eugenia brasiliensis ...	Brazil cherry ...	
	„ javanica ...	Wax jambo ...	
	Bertholletia excelsa ...	Brazil nut ...	
Lythraceae ...	Punica Granatum ...	Pomegranate ...	Delima
Cucurbitaceae ...	Citrullus vulgaris ...	Water melon ...	Beteka
Sapotaceae ...	Chrysophyllum Cainito	Star apple ...	
	„ monopyrenum	Date plum ...	
Apocynaceae ...	Catissa carandas ...	...	Kerandang
Urticaceae	Artocarpus polyphemia	...	Chempedak
	„ incisa ...	Bread fruit ...	Sukum
	„ Gomeziana	...	Tampang
	„ lakoocha ...	...	„ manis
	„ odoratissima	Marang	
	Ficus Carica	Fig ...	
Euphorbiaceae ...	Baccaurea parviflora ...	...	Setambon
	„ malayana ...	...	Tampoi
	Cicca asidissima ...	...	Chermei
Aroideae	Monstera deliciosa ...		
Palmae	Zalacca edulis	...	Buah salak

Indigenous fruits, infrequently cultivated, but collected and eaten by natives.

Natural order.	Scientific name.	English name.	Malay name.
Anonaceae ...	Uvaria Ridleyi ...	...	Ladak
Polygaleae ...	Xanthophyllum obscurum	...	Buah Kapas
Guttiferae ...	Garcinia Prainiana ...	...	Cherpu
	„ Hombroniana	...	Manggis hutan
	„ nigro-lineata	...	Kandis
	„ Griffithii ...	...	„ Gajah
	„ dulcis ...	...	Mundu
Tiliaceae ...	Grewia fibrocarpa ...	...	Chenderai rimba or Chenderai hutan
	„ latifolia ...		
Oxalideae ...	Connaropsis Griffithii ...	...	Purpoi
	„ monophylla	...	Belimbing kra
Burseraceae ...	Canarium Kadondon ...	...	Kedondong mata-hari
	„ nitidum ...	...	„ hutan
	„ rufum ...	...	„ bulan
	„ secundum ...	...	Kesambi
Celastrineae ...	Salacia grandiflora ...	...	Nasi Sejuk or Empedal ayam
Rhamneae ...	Zizyphus calophylla ...	...	Akar d a w a i-dawai
Sapindaceae ...	Nephelium glabrum ...	...	Redan
	„ eriopetalum	...	Rambutan Kabong
	Xerospermum muricatum	...	„ Pachat
	Erioglossum edule ...	...	Mertajam

Indigenous fruits, infrequently cultivated, but collected and eaten by natives—(cont.)

Natural order.	Scientific name.	English name.	Malay name.
Leguminosae	Cynometra cauliflora	...	Namnam
Leguminosae	Dialium laurinum	...	Keranji papan
	„ indum	...	Assam Keranji
	„ Maingayi	...	Keranji darat
	„ patens	...	„ umbut
	„ platysepalum	...	„ burong
	Parkia speciosa	...	Petai
	Pithecolobium lobatum	...	Jering
Rosaceae	Rubus moluccanus	Wild raspberry	Tempu ranak
	„ rosaefolius	Hill „	
	Parinarium nitidum	...	Tembatu or Merbatu kechil
Lythraceae	Sonneratia alba	...	Perupat
Rubiaceae	Morinda tinctoria	...	Mengkudu
Vaccineaceae	Vaccinium malaccense		
Myrsineae	Ardisia crenulata		Mata pelandok
Sapotaceae	Mimusops Elengi	...	Bungah tanjong
	„ Kauki	...	Sauh
Urticaceae	Artocarpus Kunstleri	...	Terap
	„ rigida	Monkey Jack	Tampunei
Euphorbiaceae	Elateriospermum Tapos	...	P'rat
Cupuliferae	Castanopsis Wallichiana	...	Berangan
Amaryllideae	Curculigo latifolia	..	Lumbah
Palmae	Nipa fruiticans	Nipa palm	Nipah

Fruits suitable only for growing on the hills in Malaya.

Natural order.	Scientific name.	English name.	Malay name.
Rosaceae	Fragaria vesca	Strawberry	
	Eriobotrya Japonica	Loquat	
Passifloreae	Passiflora edulis	Passion fruit	
Solanaceae	Cyphomandra betacea	Tree tomato	
Urticaceae	Morus indica	Indian mulberry	

REVISED DISTRIBUTION OF PINK DISEASE BY MUKIMS.

By F. W. South.

IN the *Agricultural Bulletin*, Vol. V, No. 1 of October, 1916, a list was published showing the distribution of Pink Disease by mukims so far as it was known up to the end of May, 1916. Below is given a revised list showing its spread into a few new mukims and completing the record for certain parts of the country where observations had not been made. Thus in the original list there were no records for the mukim of Sitiawan and the mukims in the Lower Perak district along the Perak River; it has since been found that the river mukims are free from the disease and only one case has so far been recorded in Sitiawan mukim. The observations made in Pahang have been fairly extensive and the records for that State are now fairly complete. A general survey of the distribution of the disease in Johore is given, though details for mukims and districts are not yet completed.

It has been noticed that in some of the districts in northern Perak which have been infected for some time there is an improvement which is probably attributable to the increased age of the rubber, as older trees do not appear to be so badly attacked as younger trees. It will be noticed that in northern Selangor the disease is slowly spreading southward and westward. In southern Selangor and the Negri Sembilan the disease is never so bad as it is further north, and is, moreover, far more periodical. Even in districts marked bad it may disappear practically entirely for a time and then re-appear. There are usually two such outbreaks each year often when a week of dry weather has followed a spell of rain.

Table showing the number of estates from which Pink Disease has been recorded.

State.	Recorded in 1917.	Previously recorded.	Total.	
Perak North	4	82	86	133
Perak South	2	45	47	
Selangor	7	28	35	
Negri Sembilan	13	30	43	
Pahang	2	2	4	
Johore	No new figures.	7	7	
	28	194	222	

PERAK.

Krian District.

Mukim.	Intensity of infection in May, 1916.	Age of infection in May, 1916.	Present condition end of 1917.
Parit Buntar	Slight	New ...	Slight
Kuala Kurau	,, ...	,, ...	,,
Bagan Serai	Medium ...	,, ...	,,
Brieh	Bad	Old ...	Bad
Gunong Semanggol ...	,, ...	,, ...	Medium
Selinsing	Medium	,, ...	,,

Larut and Matang District.

Sungei Tinggi ...	Medium ...	Old ...	Medium
Trong	Bad	,, ...	Bad in places
Sungei Limau ...	Medium ...	,, ...	Slight
Simpang	,, ...	,, ...	Medium
Bukit Gantang ...	,, ...	,, ...	,,
Jebong	,, ...	,, ...	,,
Pengkalan A'or ...	,, ...	,, ...	Slight
Tupai	,, ...	,, ...	Medium in places
Kamunting	Bad	,, ...	Medium
Assam Kumbang ...	,, ...	,, ...	Bad in places
Batu Kurau	,, ...	,, ...	Bad

Sub-District of Selama.

Ulu Ijok	Slight	New ...	Slight
Selama	Bad	Old ...	Bad
Ulu Selama	Medium ...	,, ...	Medium

Upper Perak District.

Blukar Semang ...	No report ...	... ...	...
Blum	,, ...	... ...	...
Kroh	,, ...	... ...	...
Krunai	Slight	New ...	Slight
Temengoh	,, ...	,, ...	,,
Grik	Medium ...	,, ...	Medium
Kemering	Slight	,, ...	Slight
Temelong	Medium ...	Old ...	Medium
Lenggong	,, ...	,, ...	Bad in places
Durian Pipit	,, ...	,, ...	,,

PERAK—(*cont.*)

KUALA KANGSAR DISTRICT.

Mukim.	Intensity of infection in May, 1916.	Age of infection in May, 1916.	Present condition end of 1917.
Pulau Kamiri ...	Bad in places ...	Old ...	Bad
Chegar Galah ...	Medium ...	„ ...	„
Kota Lama Kiri ...	„ ...	„ ...	Bad in places
Kota Lama Kanan ...	„ ...	„ ...	„
Saiong	„ ...	„ ...	Bad
Lubuk Merbau ...	„ ...	„ ...	Medium
Kampong Buaya ...	„ ...	„ ...	„
Senggang	Slight	New ...	Slight
Blanja	„	„ ...	Medium
Laiang-Laiang ...	„	„ ...	Slight
Bota	„	„ ...	„
Lambor	„	„ ...	„

KINTA DISTRICT.

Sungei Trap	One case in 1915 ...	...	None since
Ulu Kinta	...	...	Slight

BATANG PADANG DISTRICT.

Chenderiang	Slight	New ...	Bad
Batang Padang ...	Bad	Old ...	„
Bidor	„	„ ...	„
Sungkai	„	„ ...	„
Slim	„	„ ...	„
Ulu Bernam	„	„ ...	„

LOWER PERAK DISTRICT.

Changkat Jong ...	Slight	New ...	Medium
Sungei Durian ...	„	„ ...	Slight
Durian Sebatang ...	„	„ ...	Medium
Sitiawan	... ...	...	One case in 1917

No cases found in the up river mukims.

SELANGOR.

ULU SELANGOR DISTRICT.

Ulu Bernam	Bad but improving	Old ...	Medium
Kuala Kalumpang ...	... ...	...	Very slight
Kalumpang	Less bad than formerly ...	Old ...	Slight
Sungei Gumut ...	... ...	...	„
Kerling	Slight	New ...	„
Ampang Pechah ...	Moderate ...	„ ...	„

SELANGOR—(*cont.*)

ULU SELANGOR DISTRICT—(*cont.*)

Mukim.	Intensity of infection in May, 1916.	Age of infection in May, 1916.	Present condition end of 1917.
Peretak	... ...	... ...	Very slight
Kuala Kubu	... ...	... ...	,, ,,
Buloh Telor	... ...	... ...	,, ,,
Rasa	A few cases ...	New ...	Medium
Batang Kali	Moderate ...	Old ...	Slight
Ulu Yam	Bad	,, ...	Bad in some places, otherwise medium
Serendah	Moderate to slight ...	New ...	Medium
Rawang	A few cases only	,, ...	Medium and increasing

KUALA SELANGOR DISTRICT.

Batang Berjuntai ...	A few cases only	New ...	A few cases only
Kuala Selangor ...	None	None ...	One case in 1917

KUALA LUMPUR DISTRICT.

Batu	None	None ...	One or two cases in 1917

KLANG DISTRICT.

Bukit Raja	None	None ...	One case in 1917

ULU LANGAT DISTRICT.

Kajang	Slight	New ...	Slight
Semenyih	Moderate to slight ...	,, ...	Moderate to slight
Beranang	Slight	,, ...	Slight

NEGRI SEMBILAN.

SEREMBAN DISTRICT.

Setul	... ...	... ...	Medium
Lengeng	... ...	... ...	Slight
Labu	From bad in parts to medium and slight in others ...	Old ...	Medium
Pantai	Very Slight ...	New ...	,,
Seremban	Medium on eastern border ...	Uncertain	,,
Ampangan	... ...	... ...	Slight
Rantau	... ...	... ...	,,

NEGRI SEMBILAN—(*cont.*)

JELEBU DISTRICT.

Mukim.	Intensity of infection in May, 1916.	Age of infection in May, 1916.	Present condition end of 1917.
Ulu Klawang	...	...	Slight
Kuala Klawang	Slight and scattered	New	,,
Kenaboi	...	...	,,
Jerang	...	...	,,
Glami Lami	...	...	,,
Pertang	Medium	Old	Medium

KUALA PILAH DISTRICT.

Ulu Muar	Slight formerly, but free on last inspection	New	Slight
Pilah	...	...	,,
Sri Menanti	...	...	,,
Terachi	...	...	,,
Ampang Tinggi	...	...	,,
Juasseh	...	...	,,
Kuala Jempul	Formerly slight, but treated and now free for several months	New	,,
Jelai	...	...	,,
Rompin	...	...	,,
Ulu Jempol	...	...	,,
Johol	...	...	,,
Kepis	...	...	,,

TAMPIN DISTRICT.

Chembong	Now practically free, infection only slight	New	Slight
Pedas	Medium near Seremban border to slight elsewhere	...	Medium

PAHANG.

RAUB DISTRICT.

Semantan Ulu	Slight	New	Medium
Gali	...	...	Slight
Doug	...	...	,,
Tras	...	...	Bad
Bentong	Slight	New	Slight

PAHANG—(*cont.*)

TEMERLOH DISTRICT.

Mukim.	Intensity of infection in May, 1916.	Age of infection in May, 1916.	Present condition end of 1917.
Perak	A few cases	New	Bad
Bangau			„
Mentakab			„
Semantan			„
Triang			Slight
Kertau			„
Jenerak			Moderate

KUALA LIPIS.

Budu			Moderate
Kuala Lipis			Bad
Telang			Slight, trees mainly quite young
Gua	Slight	New	„ „
Kechau			„ „
Penjom	Slight	New	Moderate
Cheka	„	„	Slight, trees mainly quite young
Kuala Tembling			Slight

KUANTAN.

Kuantan	Slight	New	Slight
Sungei Karang			No information
Pinoh			Slight

JOHORE.

Detailed information by mukims is not yet available for this State. The following information is, however, taken from the annual report of the Assistant Agricultural Inspector for 1917.

Pink Disease is generally present over the whole State, but on many estates only isolated cases are reported. The Muar district is fairly free, only a few cases having been reported. From Gemas to Labis the disease is fairly bad, but from Labis to Johore Bahru there are only a few cases here and there with a bad spot at Kulai. Johore Bahru district is singularly free, but a thorough inspection of all the district within six miles of Johore Bahru has shown an isolated case here and there. One estate in this district has had trouble with this disease. The disease is still present in Kota Tinggi district but no exact information was available as to the extent of the infection. Kukub is believed to be free from the disease, but the Assistant Agricultural Inspector was not certain as he had only visited the district once. If any occurs around Batu Pahat it is limited to very few cases.

MINUTES OF MEETING OF ADVISORY COMMITTEE, DEPARTMENT OF AGRICULTURE,

HELD AT THE OFFICES OF THE DEPARTMENT, ON APRIL 23RD, 1918, AT 10.30 A.M.

PRESENT:—Mr. L. Lewton-Brain (Director of Agriculture). Chairman, Messrs. C. Bell, W. de L. Brooke, J. S. Ferguson, T. W. Hodge, L. A. Irving, J. D. McCulloch, A. B. Milne, L. Mooijaart, R. W. Munro and Mr. B. Bunting (Assistant Agriculturist), Honorary Secretary.

ABSENT:—The Hon'ble Mr. R. C. M. Kindersley, Messrs. H. Armstrong, W. S. Cookson, R. H. Phillips and C. Ritchie.

Messrs. F. W. South and G. E. Coombs attended the meeting.

1.—MINUTES.

The minutes of the previous meeting held on 30th January, 1918, having been circulated were taken as read and after including the name of Mr. A. B. Milne as an absent member and inserting the words "Mr. Kindersley had suggested" in place of "Mr. Kindersley suggested," in connection with the discussion on Experimental Farms, the minutes were confirmed.

2.—PROGRESS REPORTS.

The quarterly progress reports of officers of the Department having previously been circulated were laid on the table and the Chairman invited discussion.

Mr. MCCULLOCH asked for further information regarding the new bark disease mentioned in the report of the Chief Agricultural Inspector.

Mr. SOUTH replied that it was a disease newly reported by the Assistant Agricultural Inspector, Negri Sembilan, and was now under investigation.

Mr. FERGUSON asked if anything had been done to prevent the spread of the recent attack of leaf hoppers on padi reported in the Krian District.

Mr. SOUTH replied that the damage due to the pest had unfortunately mostly been done before it was reported to the Department and at the time when energetic measures were being prepared for its eradication the pest was practically wiped out by rain and no further action was necessary. The total area involved was probably about 400 acres scattered in small patches over an area of about 3,000 acres and the estimated damage might be put down at about $200,000.

Mr. COOMBS understood this pest was very prevalent in Kedah, Ceylon and Southern India but previous to the present attack it had never done any serious damage to padi in this country.

Mr. MUNRO thought that with the increase in the areas under food-stuffs such as millet, ragi, sorghum, etc., insect attacks would become much more prevalent and where large areas were under one particular crop the planter would have to guard against the attacks of insect pests which might never appear on a small trial plot.

3.—STOCK BREEDING.

The Honorary Secretary read a letter from the Hon'ble Mr. R. C. M. Kindersley giving an account of the visit which he paid, together with Mr. W. de L. Brooke, to the Hongkong Dairy Farm. The farm consisted of cattle, pigs and poultry and was evidently a very prosperous business concern. He, Mr. Kindersley, considered it highly desirable that Mr. Ellis should visit the farm at an early date.

Mr. BROOKE described the visit and agreed with Mr. Kindersley.

Mr. MILNE asked what was the principal idea in starting a Stock Breeding Farm.

The CHAIRMAN replied that the primary object was to improve the live stock of the country ; *inter alia*, it should result in improving the dairy farming.

It was agreed that when the Hon'ble Mr. Kindersley returned from Hongkong the Chief Secretary be asked to receive a deputation consisting of the Chairman, the Hon'ble Mr. Kindersley, Mr. Brooke and Mr. Ellis (Assistant Agricultural Inspector, Perak) to discuss the possibility of starting the scheme.

The CHAIRMAN reported that the Food Production Committee had recommended that a small sum of money should be devoted to the purpose of importing a number of pairs of a good strain of poultry from India.

The Committee heartily thanked the Hon'ble Mr. Kindersley and Mr. Brooke for the trouble they had taken in collecting the information with regard to the Hongkong Dairy Farm.

4.—PESTS AND DISEASES.

A circular with regard to the incidence of "brown bast" was discussed and some additions made. It was agreed that the circular should be distributed through the Secretaries of the various District Planters' Associations, who would be informed of the objects of the circular and that the information gathered would be treated as confidential.

5.—AGRICULTURAL EDUCATION.

The CHAIRMAN read the evidence he had given on the question of Agricultural Education which he had submitted to the Committee appointed by Government to report on Technical Education in the Federated Malay States.

He considered that although an Agricultural School should be a separate institution with its own staff and distinct from any Technical School, it should be situated near the Department in order to allow expert officers to lecture on special subjects. He had suggested that, if a man could be obtained to take charge, it might be arranged to start the scheme at the offices of the Department where a limited amount of accommodation was available for providing the students with temporary quarters. A reserve of 1,000 acres had been set aside for such a school at Kepong and as the scheme becomes more advanced this area would be opened up and suitable buildings erected to accommodate at least 100 students.

The Committee unanimously approved of the suggestions made by the Director of Agriculture.

6.—EXPERIMENTAL COCONUT PLANTATION.

The CHAIRMAN informed the meeting that he had now made arrangements for Mr. Lambourne to devote the greater part of his time to Sipantas Estate. Mr. Munro explained that since the new arrangement the out-turn of coolies had increased considerably, with the result that a much larger amount of work had been carried out. After some further discussion the Chairman stated that he had arranged with Mr. Munro to furnish quarterly reports which would be circulated to the Committee.

Mr. MUNRO suggested that the sub-committee for the coconut experimental plantation be enlarged and suggested that Mr. R. H. Phillips be asked to serve. This was unanimously agreed to.

7.—COCONUT OIL EXTRACTION.

With reference to the local extraction of coconut oil the Chairman explained that he had so far been unable to arrange a special meeting owing to the absence of a number of people interested from the country. It was agreed to try to arrange a meeting in May.

8.—NEW AGRICULTURAL INDUSTRIES.

With reference to large scale experiments on new agricultural industries the Chairman reported that the Chief Secretary asked for detailed estimates before coming to a decision with regard to starting a plantation in the Federated Malay States. It is agreed to refer this to the sub-committee on experiments, it being remarked that as one of the objects of the proposed scheme was to discover costs, it would be impossible to frame estimates at all accurately.

As regards reserves the Chairman reported that the position stood as follows: Two large reserves had been provisionally set aside in Pahang and would be reported on as soon as a Chemist could be spared. It had been found impossible to convert the Bangi Forest Reserve. In Lower Perak the District Officer recommended that the selection of land be deferred until he knew whether certain land was available. The reserve to the north of the Selangor River was still held, but could not be utilised till road communication was available. The Johore Government had agreed to set aside a reserve.

With regard to private enterprise and new industries after some discussion it was agreed to ask the Government to define its policy as regards the alienation of land for the purpose of growing food-stuffs or other products of an experimental nature.

9.—LECTURES TO PLANTERS.

The CHAIRMAN asked the opinion of the Committee as to the desirability of discontinuing the lectures which had been arranged to be given by officers of the Department.

After some discussion it was agreed that Secretaries of District Planters' Associations be written to informing them that the series arranged for the present year would be discontinued, but that an endeavour would be made to meet the wishes of any Association that specially asked for a lecture.

10.—RUBBER GENETICS.

The CHAIRMAN reported that the scheme for rubber breeding recommended by the Committee at the meeting on 30th May, 1917, had been accepted by the Federated Malay States Government and that the appointment of a Geneticist, a Plant Physiologist and an additional Assistant Mycologist had been approved. When these appointments were filled it would be possible to commence work on this important subject.

The meeting terminated at 12.45 p.m.

TABLE I.

Agricultural Acreage, Federated Malay States, 1916 and 1917, excluding Padi and Horticulture from Estates over 100 acres in extent.

	Selangor.		Perak.		Negri Sembilan.		Pahang.		Total.	
	1916.	1917.	1916.	1917.	1916.	1917.	1916.	1917.	1916.	1917.
Coconuts	22,511	22,939	30,531	37,571	1,935	2,176	2,587	2,902	57,564	65,588
Rubber	229,091	254,091	191,329	210,820	119,150	141,886	12,389	14,825	551,959	621,622
Coffee	1,788	1,622	757	1,193	9	7	...	...	2,554	2,822
Other Cultivations	1,767	587	1,780	1,891	2,574	1,337	10	9	6,131	3,824
Total ...	255,157	279,239	224,397	251,475	123,668	145,406	14,986	17,736	618,208	693,856

TABLE II.

Agricultural Acreages, Malaya, 1917, from Estates over 100 acres in extent.

—	Federated Malay States.	Straits Settlements.	Johore.	Kelantan and Kedah.	Trengganu.	Grand Total.
Rubber alone	612,268	150,048	160,954	99,970	3,120	1,026,360
„ and Coffee	1,167	2	...	177	...	1,346
„ „ Coconuts	2,804	228	70	338	...	3,440
„ with Other Crops	5,383	2,911	1,351	4,999	30	14,674
Total ...	621,622	153,189	162,375	105,484	3,150	1,045,820
Coconuts alone	59,631	21,174	2,182	7,157	7,779	97,923
„ and Coffee	1,528	160	...	...	...	1,688
„ with Other Crops exclusive of Coffee	4,429	1,680	55	628	...	6,792
Total ...	65,588	23,014	2,237	7,785	7,779	106,403
Coffee alone	127	...	...	...	...	127
„ with Other Crops	2,695	162	...	177	...	3,034
Total ...	2,822	162	...	177	...	3,161

TABLE III.

Rubber Statistics, Federated Malay States, up to 31st December, 1916, and 1917, from Estates over 100 acres in extent.

	Selangor.		Perak.		Negri Sembilan.		Pahang.		Total.	
	1916.	1917.	1916.	1917.	1916.	1917.	1916.	1917.	1916.	1917.
No. of Estates	356	364	375	393	190	218	33	49	954	1,024
Acreage in possession ...	382,667	391,793	349,010	364,728	224,843	241,523	40,954	46,795	997,474	1,044,839
Acreage planted up to 31st December, 1916 and 1917 ...	229,091	254,091	191,329	210,820	119,150	141,886	12,389	14,825	551,959	621,622
Rubber alone	226,560	251,665	188,260	206,855	116,580	139,018	12,329	14,730	543,729	612,268
Rubber interplanted with catch-crops	2,531	2,426	3,069	3,965	2,570	2,868	60	95	8,230	9,354
Acreage producing	150,993	171,763	122,683	146,382	72,199	83,097	5,347	7,332	351,222	408,574
Planted during 1916 and 1917	17,387	25,000	25,081	19,491	9,427	22,736	585	2,436	52,480	69,663

TABLE IV.

Rubber Statistics, Malaya, up to 31st December, 1916 and 1917, from Estates over 100 acres in extent.

	Federated Malay States.		Johore.		Kelantan and Kedah.		Trengganu.		Straits Settlements.		Total.	
	1916.	1917.	1916.	1917.	1916.	1917.	1916.	1917.	1916.	1917.	1916.	1917.
No. of Estates ...	954	1,024	154	150	149	185	6	6	212	269	1,475	1,634
Acreage in possession	997,474	1,044,839	360,140	362,209	230,873	233,275	16,680	17,180	247,569	251,490	1,857,157	1,908,993
Acreage planted up to 31st December, 1916 and 1917 ...	551,959	621,622	153,691	162,375	98,436	105,484	2,645	3,150	145,139	153,189	951,870	1,045,820
Rubber alone ...	543,729	612,268	148,169	160,954	90,430	99,970	2,645	3,120	141,584	150,048	926,557	1,026,360
Rubber interplanted with catch-crops ...	8,230	9,354	5,522	1,421	8,006	5,514	...	30	3,555	3,141	25,313	19,460
Acreage producing ...	351,222	408,574	65,920	84,690	37,368	39,812	610	1,310	88,436	98,543	543,556	632,929
Planted during 1916 and 1917	52,480	69,663	22,295	8,684	28,387	7,048	34	505	15,605	8,050	118,801	93,950

Table V.

Comparative Table of Rubber Crops, Malaya, 1908 to 1917.

State.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.
	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.
Selangor	824 6	1,641 5	3,148 13	5,106 14	7,482 6	10,110 15	12,601 6	16,061 11	19,996 11	24,573 3
Perak	171 0	473 9	1,322 8	2,697 4	4,116 18	6,623 17	8,959 7	12,112 1	17,336 18	19,453 2
Negri Sembilan ...	430 0	601 2	1,160 12	1,918 12	2,518 16	3,339 16	4,203 18	8,138 1	8,596 14	12,223 3
Pahang	...	...	1 2	13 18	74 14	155 9	337 19	548 13	682 8	1,010 13
Johore	90 0	146 5	296 12	404 2	968 6	1,645 7	2,861 7	4,711 2	6,840 7	8,193 7
Kelantan and Kedah...	...	...	18 11	23 0	79 6	246 18	1,383 18	1,955 0	3,687 7	4,636 15
Trengganu	...	...	...	...	...	...	...	...	17 12	92 7
Malacca	23 13	16 9	267 16	382 11	1,742 6	3,549 2	3,979 16	5,181 1	6,606 12	7,376 16
Province Wellesley *...	41 7	131 1	198 19	571 15	1,973 16	2,498 12	3,076 8	3,177 11	3,912 11	4,760 1
Total ...	1,580 6	3,009 11	6,414 13	11,117 16	18,956 8	28,169 16	37,403 19	51,885 0	67,677 0	82,319 7

* Including Singapore, Penang and Dindings.

TABLE VI.

Estate Labour, Federated Malay States, 1917, from Estates over 100 acres in extent.

—	Selangor.	Perak.	Negri Sembilan.	Pahang.	Total
Tamil men	51,707	46,053	10,339	1,401	109,500
„ women	17,382	13,953	2,683	159	34,177
„ children	6,486	3,844	644	29	11,003
Javanese men	2,158	2,496	948	1,302	6,904
„ women	100	1,301	153	575	2,129
Malays	1,077	6,166	2,048	289	9,580
Chinese	15,126	14,070	22,396	1,878	53,470
Others	647	1,056	353	31	2,087
Total ...	94,683	88,939	39,564	5,664	228,850

TABLE VII.

Estate Labour, Malaya, 1917, from Estates over 100 acres in extent.

—	Federated Malay States.	Johore.	Kelantan and Kedah.	Trengganu.	Straits Settlements.	Total.
Tamil men	109,500	9,049	7,739	23	17,564	143,875
„ women	34,177	1,716	1,934	...	5,585	43,412
„ children	11,003	406	498	...	1,257	13,164
Javanese men	6,904	5,242	1,039	5	2,584	15,774
„ women	2,129	769	58	...	624	3,580
Malays	9,580	3,831	9,969	1,520	4,922	29,822
Chinese	53,470	16,795	12,838	1,371	13,919	98,393
Others	2,087	881	315	...	1,249	4,532
Total ...	228,850	38,689	34,390	2,919	47,704	352,552

Rubber Statistics for 1917, from Holdings less than 100 acres in extent.

Districts.	Acreage planted.	Acreage in bearing.	Number of trees tapped.
PERAK.			
Krian	7,843	1,907	381,500
Larut	30,000	11,493*	1,723,955*
Kuala Kangsar	31,965	14,356	2,153,400*
Upper Perak	5,307	1,403	210,450*
Kinta	29,426	9,799	1,469,850*
Batang Padang	16,883	7,062*	1,059,429
Lower Perak	14,320	5,276	791,400*
Total ...	135,744	51,296	7,789,984
SELANGOR.			
Kuala Lumpur	10,248	7,925	1,188,750*
Klang	12,301	4,743	948,600†
Ulu Langat	23,000	6,600	990,000*
Kuala Langat	11,417	3,811	762,318
Ulu Selangor	10,000	7,000	1,050,000*
Kuala Selangor	6,292	2,129	319,350*
Total ...	73,258	32,208	5,259,018
NEGRI SEMBILAN.			
Seremban	13,136	10,946*	1,642,040
Kuala Pilah	15,824	5,124	768,600*
Tampin	5,500‡	3,750‡	562,500*
Port Dickson	3,762	1,269	253,850
Jelebu	1,221‡	777*	116,685‡
Total ...	39,443	21,866	3,343,675
PAHANG.			
Lipis	2,526	481*	72,275
Raub	7,800	1,850	277,500*
Kuantan	11,500	622*	93,333*
Pekan	469	90*	13,513*
Temerloh	1,122§	1,122	168,300*
Total ...	23,417	4,165	624,921

* Calculated at the rate of 150 trees to an acre.

† Calculated at the rate of 200 trees to an acre.

‡ Not accurate, but according to the licences issued.

§ Not accurate.

Abstract of Meteorological Readings in the various Districts of Malaya for the month of December, 1917.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Kota Bahru	...	151.0	78.6	80.32	74.45	5.87	75.0	.799	72.5	82.0	...	64.16	11.35
Pahang, Kuala Lipis	...	...	78.71	87.19	72.0	15.12	74.51	...	...	...	...	8.47	1.66
Johore, Johore Bahru	...	...	...	84.50	71.93	...	...	...	...	...	...	14.99	4.02
Singapore, Kandang Kerbau ...	29.771	161.0	79.36	85.5	73.0	12.5	75.83	.839	...	84.3	...	11.06	1.88
Malacca, Durian Daun ...	29.821	162.0	79.7	90.0	70.0	13.8	77.0	.893	...	88.0	N.E.	6.71	1.67
Negri Sembilan, Seremban ...	...	145.8	78.4	85.3	71.1	14.2	75.1	.811	72.8	83.6	N.W.	12.29	2.00
„ Kuala Pilah ...	...	143.4	79.9	87.8	69.6	18.2	77.6	.896	75.9	87.9	...	9.96	1.88
„ Port Dickson...	...	113.1	79.5	85.1	72.9	12.2	76.3	.847	74.4	83.9	...	10.94	1.88
Selangor, Kuala Lumpur ...	29.769	143.6	79.7	86.7	72.3	14.4	74.7	.818	73.1	79.0	N.E.	11.43	2.79
„ Klang	...	...	78.3	82.5	72.0	10.5	75.1	...	...	...	...	12.76	2.29
„ Kuala Selangor ...	...	...	...	86.1	73.5	12.6	...	...	...	...	...	12.29	3.50
„ Rawang	...	...	...	89.6	...	...	...	...	...	...	...	7.38	1.61
Perak, Telok Anson	...	...	79.36	89.0	71.0	18.0	76.15	.859	...	87.0	...	10.47	3.85
„ Ipoh	...	...	79.81	91.0	70.0	21.0	75.60	.832	74.05	82.0	...	7.28	1.73
„ Taiping	...	109.0	78.61	92.0	70.0	22.0	75.59	.844	...	86.0	...	14.99	2.71
„ The Cottage	...	...	...	...	...	...	...	...	...	...	...	21.65	3.22
„ Parit Buntar	...	...	80.28	91.0	71.0	20.0	76.36	.857	...	85.0	...	4.72	1.41
Penang, Georgetown	29.763	140.0	80.53	86.40	70.96	...	78.58	.921	77.3	93.16	N.W.	3.93	.98
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	7.09	1.38
Perlis, Kangar	...	...	...	83.35	70.65	12.70	...	...	...	...	...	5.31	1.03